SCIENCE

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DROPSICAL DISEASES OF PLANTS.

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RECENT progress in the study of fungi and bacteria has revealed many standing in casual relation to several plant diseases which were of a hitherto mysterious nature and which were supposed to have been due to atmospheric or solar influences. The effect has been to create a firm belief in the germ theory of plant diseases, and there is consequently a strong tendency in certain quarters to apply the germ theory to all cases of phytopathology. The first fruits of investigations leading to the determination of bacteria and fungi as the cause of certain obscure blights of plants were either rejected *in toto*, or received *cum grano salis*. Now it is the fad to attribute all phases of disturbance, short of artificial injuries or those violent injuries produced by the elements, to the agencies of micro-organisms.

It must be urged, however, that there are some purely physiological diseases of plants. But so strong just now is the leaning to the germ theory that any departure from this path must be fortified by very careful experiments and inoculations with the germs associated with the trouble in order to carry conviction not only to one's self but to others.

The writer had occasion last winter to investigate a very mysterious disease of tomatoes[1] grown in the forcing houses of Cornell University. Typical cases of the disease presented the appearance so characteristic of certain mildews. The leaves were strongly curled and the veins on the under side were swollen and whitened. Large patches of the same kind were also found to exist on the stems. Contrary to expectation, a microscopic examination did not show the presence of any fungus of ordinary dimensions in the early stages of the trouble. The young and succulent tissues of the plant were strongly turgescent and the cells in the affected areas were stretched radially to an enormous extent. These tissues ultimately collapsed and in many instances the loss of water content from these places was so great that the affected parts of the plants died. In other cases the loss of water was more gradual where the turgescence and rupture of the cells were not so profound. Then the cushions of collapsed tissue were dry, and presented a tomentose appearance, and the effect upon the adjacent tissues was to interfere with the assimilatory processes, causing the upper parts of the leaves at these spots to become yellowish in color. On the stems there resulted from the collapse of the tissues elongated, depressed and blackened areas in various stages of decomposition. These sometimes extended far beyond the first appearance of the cushions of elongated cells, showing that the trouble once started would extend to other parts of the plant.

The question now to be considered was, Are these abnormal extensions of tissue caused by the influence of some microsymbion within the plant? Healthy plants were inoculated with the material taken directly from affected tissues. No result.

Dilution cultures were then made from several different affected places and fifteen different species of bacteria were obtained, three of *Bacillus*, three of *Micrococcus*, and nine of *Bacterium*. Cultures of these were made in liquid media and healthy plants were inoculated, but there was no result.

These negative results from inoculation and also the fact that when using the necessary precautions to prevent the entrance of gems from the outside, no growth occurred when culture media were inoculated with material from the interior of freshly affected areas of the plant, led to the conclusion that the trouble was due to some physiological disturbance of the plant, probably that root pressure, as it is termed, was greater than transpiration.

The conditions of the green house were such as to produce active and almost constant root absorption, while they were very unfavorable for transpiration, since there was very little disturbance of the air, the part of the house where the tomatoes were grown was poorly lighted, and the winter days were very short as compared with the nights. In the open during the summer currents of air remove quickly the water vapor given off during transpiration. This, with the longer days, favors rapid transpiration. The heating of the forcing house is also such as to make but little difference between the temperature of the soil and that of the air, and also the temperature of the soil is such as to make the roots active almost continually, while in the open there is a much greater difference between the temperature of the soil and air, in such ratio in the summer that root pressure and transpiration are more evenly balanced.

Cuttings of healthy plants were then connected with the hydrant by means of rubber tubing, the pressure of water turned on being twenty to thirty pounds. The pressure of water was so great that in a very few minutes drops of water stood out at the ends of the veins on the margins of the leaves. In a few days, since this abnormal pressure was in excess of transpiration, cushions of turgescent tissue exactly like those developed under the conditions of the forcing huse, were produced.

Another proof that the cause of the trouble was excessive turgescence is furnished by the relation of growth to the trouble. Where active growth was taking place in the cells the radial elongation did not take place. The increase in number of cells and the natural increase of the size of the cells were sufficient to accommodate the amount of water distributed to those parts of the plant. So that when there was no immediate interference with the growth of the terminal portions of the plants there were no cushions developed on the ends of the stem or branches for a distance of four to six inches. But just so soon as the growth by increase of cells ceased the cushions of turgescent tissue appeared. Also in the case of some plants on one bench, when the tops reached the glass roofing and the confined condition interfered with growth, the trouble appeared even to the extreme tips of the stem and branches. It is also to be noted that the short days and poor lighting of the house gave little opportunity for the metabolic processes in the manufacture of building material for the formation of strong cell walls.

Recently a similar trouble has fallen to my lot to investigate, which occurred on apple trees. Numerous blisters appeared on the trunk and branches of young and vigorous orchard trees. These blisters were caused by the radial elongatian of the phellogen layer of cells just beneath the periderm. The tissues ultimately collapsed, and were then subjected to the attacks of putrefactive bacteria and fungi. Inquiry of the owner developed a fact which was already inferred, that the plants were under such conditions that growth was very rapid, and then during the winter and spring were subjected to

[1] Oedema of the tomato, Bull. 53, C. U. Exp. Sta., May, 1893.

a very severe pruning. When growth began in the spring there were no leaves to produce active transpiration, and but few growing points to accommodate the excess of water which the large root system was continually pumping up. The excess of water in the phellogen layer was drawn into the interior of the cell protoplasm by the vegetable acids, and since it could not filter out readily, nor be removed sufficiently fast by transpiration, the cells were abnormally stretched and at last collapsed.

Similar troubles have been recorded as appearing on other plants, as potatoes,[2] grapes,[3] rose and plum seedlings, gooseberries, beans[4] and pears[5]; and recently Halsted has recorded it on pelargoniums.[6]

THE SPEECH OF ANIMALS.

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THAT animals have a means of communication among themselves through certain vocal sounds is a well established fact; that these vocal sounds are of sufficient range to express other than mere physical ideas, and thus to assume the importance of a language, is probable, although as yet unproven. It is towards the final settlement of this question that I wish to add my mite, and, while there is much that might be said, in the present instance I will confine my observations to a field but little explored—the attempts of animals to communicate with man.

For the last three years I have had a tame fox squirrel of which I have made a great pet. Polly has occupied a cage in the laboratory where she has been, for the most part, shut off from the sights and sounds of the outside world. Although at times the laboratory has had other tenants in the shape of squirrels, rabbits and guinea-pigs, she has formed no particular attachment for any of them, but when I am about she is usually close to me, either on my shoulder or following me about like a dog.

Unconsciously at first and later with a definite purpose I have talked to her much as one would talk to a young child. About a year ago she began to reply to my conversation. At first it was only in response to my questions as to food, etc., but later her *"talk"* has assumed larger proportions until now she will, of her own accord, assume the initiative.

Her vocabulary appears to be quite extensive, and while, for the most part, it pertains to matters of food and personal comfort, there are times when it seems as though she were trying to tell me of other things.

When I first go out where she is in the morning she immediately asks for food, and until that want is supplied she keeps up a constant muttering. Later when her hunger is appeased she will ask to be let out of the cage. Often when playing about the room she will climb onto my shoulder and *"talk"* to me for awhile in a low tone and then scamper off. Unless she is sleepy she will always reply to any remark made to her.

Her speech is not the chattering ordinarily observed in squirrels, but a low gutteral tone that reminds one both of the low notes of a frog and the cluck of a chicken. Some of the notes I have been able to repeat, and invariably she becomes alert and replies to them. Unfortunately, the effort to reproduce her tones produces an uncomfortable effect on my throat, and I have been obliged to desist from further experiments in that direction. The sounds that she makes are quick and in low tone, so the attempt to isolate words is very difficult, yet there is as much range of inflection as in German.

Another reason why I believe she is endeavoring to communicate with me is that she has used the same sounds towards other squirrels confined in the same cage, and that, while she will answer any one who addresses her, she voluntarily will only talk at length to me. That she understands what is said to her is beyond question, and, furthermore, she will distinguish between a remark made to her and one made to some one else.

I have had many pets that would answer in monosyllables to a question asked them or indicate by actions their desires, but this is the first instance that has come under my observation in which an animal has attempted more that that.

When Polly first commenced *"talking,"* I regarded it merely as idle chattering, but further observation shows that it is not such, and that the sounds she makes have a definite meaning. Moreover, the sounds she makes in *"talking"* are not the shrill notes of anger or alarm, but low, clear sounds that are unmistakably articulate.

In my fondness for my pet, have I overestimated the value of the sounds she makes, or am I right in assigning to them the characters of speech? Why should an animal not attempt to communicate with man? The higher animals are possessed of a well-formed larynx and vocal chords. Why, then, should we deny or ever question the possibility of articulate speech? And, if they can converse among themselves, why may they not attempt to communicate with man?

Anyone who has owned a well-bred dog can relate numerous instances in which his dog has clearly understood what was said to it, and the readiness with which a dog learns a new command shows an intelligence of a high order. Although a dog's vocabulary is of limited range, it has certain definite sounds that possess an unmistakable meaning. There is the short, sharp bark that expresses a want, the low, nervous bark that means discomfort, the sharp, quick bark of joy, the low whine of distress, the growl of distrust, the deep growl of anger, the loud bark of warning and the whimper of fright. When to these is added the various movements of the body, cowering in fear, crouching in anger, the stiff bracing of the body in defence, leaping in joy, and many special actions, as licking the hand of the master or pulling at his clothes, we find that a dog can express his likes and dislikes, his wants and his feeling as clearly as though he were human. Anyone who, in a time of sorrow or depression, has had his dog come to him and lay its head in his lap and has looked down into those great brown eyes so full of sympathy and love, can never doubt that the dog understood all, and in its own way was trying to comfort.

A friend's cat has an unmistakable sound for yes and no. The former is a low meyouw, while the latter is a short, sharp m'yoww. If Tom wants to go out that fact is made manifest by a quick meyouw'. If, perchance, anyone should be in the chair which Tom regards as his especial property, no regard for propriety restrains him from indicating that fact and unceremoniously ordering the instructor out. His me'youw' on such an occasion can not be mistaken. Instances of this sort are not uncommon and ordinarily fail to attract attention, but is there not here a field that will well repay a careful investigation?

Until my pet squirrel commenced her performances I regarded these things as a matter of course, but her chattering has raised with me the question, Is it not possible that our animal friends are endeavoring in their own way to talk to us as we talk to them?

[2] Ward, on some relations between host and parasite. Proceedings Royal Society, XLVII, 1890, p. 393-443.
[3] Gardener's Chronicle, 1878, I. 802, and 1889, I. 503.
[4] Sorauer, Wassersucht bei Ribes aureum, Freihoff's Deutsche Gartnerzeitung, Aug. 1880.
Pflanzenkrankheiten, Zweite Auflage, I. 235-238. Goeschke, Die Wassersucht der Ribes, Monatsschrift d. Verein z. Beford. d. Gartenbaues in den kgl. Staaten, October heft. 1880, 451.
[5] Quabius, Wassersucht bei Birnen, Jahresb. d. Schles. Centralverein's fur Gartner und Gartenfreunde zu Breslau, 1881.
[6] Bulletin Torrey Bot. Club, XX., 1893, 391.